Application No. 10/501,431 Atty. Docket No. 02PCTEZ1
Amendment dated March 21, 2006
Reply to Office Action of 02/09/2006

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Amendments to the Claims:

This listing of claims will replace all prior versions and listings of claims in the application:

Listing of Claims:

1. (currently amended) A method for soldering a first substrate (12) to and in electrical connection with a second substrate (18) without using a flux or reducing atmosphere, the method characterized by:

forming a first electrically conductive pad (14) on a first surface of the first substrate (12), the first pad including an upper portion comprising at least one component of an electrically conductive eutectic alloy;

forming a corresponding second pad (16) on a first surface of the second substrate (18), the second pad including an upper portion comprising at least one other component of the eutectic alloy;

forming at least one sharp upstanding peak (50, 58) on an upper surface of at least one of the first and second pads (14, 16);

urging the respective first surfaces of the first and second substrates (12, 18) toward each other such that the respective upper surfaces of the first and second pads (14, 16) are brought together in a forceful opposing abutment with each other;

heating the opposing pads (14, 16) to at least the soldering temperature of the eutectic alloy and until the at least one sharp upstanding peak (50, 58) on the at least one pad penetrates through any oxide films (52) on the respective upper surfaces of the pads and contacts the upper surface of the opposing other pad, thereby initiating melting and dissolution of the respective upper portions of the opposing pads, including the sharp upstanding peaks, into each other; and,

cooling the opposing pads to solidify the dissolved, molten upper portions thereof into an ~~a solid, homogeneous,~~ electrically conductive joint between the pads; and,

wherein forming the at least one sharp peak (50, 58) is characterized by:

forming a lower portion (42, 44, 46, 48) of the at least one pad (14, 16, 20, 22), the lower portion comprising a metal or a semiconductor;

forming a coating (56) on an upper surface of the lower portion of the at least one pad, the coating consisting of the same at least one eutectic alloy component comprising the upper portion of the at least one pad; and,

forming the at least one peak (50, 58) on an upper surface of the coating (56), the at least one peak consisting of the same at least one eutectic alloy component comprising the upper portion of the at least one pad.

2. (previously presented) The method of claim 1, wherein:

the first substrate (12) comprises a semiconductor die;

the first pad (14) comprises one or more signal input/output pads of the die;

the second substrate (18) comprises an interconnective substrate of a semi-conductor package (10); and,

the second pad (16) comprises one or more signal connection pads of the interconnective substrate (18),

whereby the die (12) is electrically interconnected with the substrate (18).

3. (previously presented) The method of claim 2, wherein:

the first pad (14) further comprises a frame (20) around a periphery of the first surface of the die (12); and,

the second pad (16) further comprises a corresponding frame (22) around a periphery of the first surface of the interconnective substrate (18),

whereby a space (36) inside of the frames (20, 22) and between the respective first surfaces of the die (12) and the substrate (18) is closed and hermetically sealed from the surrounding ambient simultaneously with the electrical interconnection of the die with the substrate.

4. (previously presented) The method of any one of claims 1-3, wherein the at least one eutectic alloy components are selected from the group consisting of: Gold (Au); aluminum (Al); germanium (Ge); zinc (Zn); silicon (Si); cadmium (Cd); tin (Sn); copper (Cu); bismuth (Bi); silver (Ag); and, lead (Pb).

5. (previously presented) The method of any one of claims 1-3, wherein at least one of the respective upper portions of the first and the second pads (14, 16, 20, 22) is formed by a vacuum deposition process or an electroplating process.

6. (previously presented) The method of any one of claims 1-3, wherein the at least one sharp up-standing peak (50, 58) is formed by a vacuum deposition process.

7. (previously presented) The method of any one of claims 1-3, wherein the heating is effected with a laser.

8. (cancelled)

9. (currently amended) A method for soldering a first substrate (12) to and in electrical connection with a second substrate (18) without using a flux or reducing atmosphere, the method characterized by:

forming a first electrically conductive pad (14) on a first surface of the first substrate (12), the first pad including an upper portion comprising at least one component of an electrically conductive eutectic alloy;

forming a corresponding second pad (16) on a first surface of the second substrate (18), the second pad including an upper portion comprising at least one other component of the eutectic alloy;

forming at least one sharp upstanding peak (50, 58) on an upper surface of at least one of the first and second pads (14, 16);

urging the respective first surfaces of the first and second substrates (12, 18) toward each other such that the respective upper surfaces of the first and second pads (14, 16) are brought together in a forceful opposing abutment with each other;

heating the opposing pads (14, 16) to at least the soldering temperature of the eutectic alloy and until the at least one sharp upstanding peak (50, 58) on the at least one pad penetrates through any oxide films (52) on the respective upper surfaces of the pads and contacts the upper surface of the opposing other pad, thereby initiating melting and dissolution of the respective upper portions of the opposing pads, including the sharp upstanding peaks, into each other; and,

cooling the opposing pads to solidify the dissolved, molten upper portions thereof into an electrically conductive joint between the pads; and,

~~The method of any one of claims 1-3,~~ wherein forming the at least one sharp peak (50, 58) is characterized by:

forming a lower portion (42, 44, 46, 48) of the at least one pad (14, 16, 20, 22), the lower portion comprising a metal or a semiconductor;

forming the at least one peak (50, 58) on an upper surface of the lower portion of the at least one pad; and,

forming a coating (56) over the at least one peak and the upper surface of the lower portion of the at least one pad, the coating (56) consisting of the same at least one eutectic alloy component comprising the upper portion of the at least one pad.

10. (currently amended) A method for soldering a first substrate (12) to and in electrical connection with a second substrate (18) without using a flux or reducing atmosphere, the method characterized by:

forming a first electrically conductive pad (14) on a first surface of the first substrate (12), the first pad including an upper portion comprising at least one component of an electrically conductive eutectic alloy;

forming a corresponding second pad (16) on a first surface of the second substrate (18), the second pad including an upper portion comprising at least one other component of the eutectic alloy;

forming at least one sharp upstanding peak (50, 58) on an upper surface of at least one of the first and second pads (14, 16);

urging the respective first surfaces of the first and second substrates (12, 18) toward each other such that the respective upper surfaces of the first and second pads (14, 16) are brought together in a forceful opposing abutment with each other;

heating the opposing pads (14, 16) to at least the soldering temperature of the eutectic alloy and until the at least one sharp upstanding peak (50, 58) on the at least one pad penetrates through any oxide films (52) on the respective upper surfaces of the pads and contacts the upper

surface of the opposing other pad, thereby initiating melting and dissolution of the respective upper portions of the opposing pads, including the sharp upstanding peaks, into each other; and,

cooling the opposing pads to solidify the dissolved, molten upper portions thereof into an electrically conductive joint between the pads; and,

~~The method of any one of claims 1-3,~~ wherein forming the at least one sharp peak (50, 58) is characterized by:

forming a lower portion (42, 44, 46, 48) of the at least one pad (12, 14, 20, 22), the lower portion comprising a metal or a semiconductor;

forming a first coating (60) on an upper surface of the lower portion of the at least one pad, the first coating consisting of the same at least one eutectic alloy component comprising the upper portion of the at least one pad;

forming the at least one peak (50, 58) on an upper surface of the first coating (60); and,

forming a second coating (62) over the at least one peak (50, 58) and the upper surface of the first coating (60), the second coating consisting of the same at least one eutectic alloy component comprising the upper portion of the at least one pad.

11. (previously presented) The method of claim 2, further characterized by molding a monolithic body (122) of a dielectric plastic over the die (12) and at least a portion of the interconnective substrate (18), thereby hermetically sealing the die.

12. (previously presented) The method of claim 2, further characterized by placing a lid (124) over the die (12) and forming a continuous seal around a periphery of the die and between a peripheral portion of the lid and the interconnective substrate (18), thereby hermetically sealing the die.

13. (previously presented) The method of any one of claims 1-3, wherein the second substrate (18) has a second surface opposite to the first surface thereof, the second surface having a electrically conductive land (30) thereon, and further characterized by forming an electrically conductive, hermetically sealed via (32) through the second substrate connecting the second pad (16) to the land.

14. (previously presented) The method of claim 13, wherein the land (30) and the via (32) are laterally offset from the second pad (16).

15. (previously presented) A semiconductor package (10) made in accordance with any one of the methods of claims 2, 3, 11, or 12.

16. (previously presented) A semiconductor package (10) made in accordance with the method of claim 14.